ORIGINAL RESEARCH PAPER
Volume - 11 | Issue - 12 | December - 2022 | PRINT ISSN No. 2277 - 8179 | DOI : 10.36106/ijsr
INTERNATIONAL JOURNAL OF SCIENTIFIC RESEARCH

# ANALYSING PROGNOSTIC FACTORS IN TRAUMATIC CERVICAL SPINE INJURY AT A TERTIARY CARE HOSPITAL

Neurosurgery

**Dr Akshay Sainath Shirodkar** Mch Neurosurgery Resident

**Dr Vivek Yadav*** Associate Professor Neurosurgery*Corresponding Author

**Dr Amit Dagar** Associate Professor Neurosurgery

**Dr K B Shankar** Professor and Head Neurosurgery

## ABSTRACT

**BACKGROUND:** Cervical spinal cord injury is one of the common causes of severe disability and death in trauma patients. An accurate assessment of the level and severity of the Spinal Cord Injury is the key for predicting functional outcomes. This article presents the prognostic value and clinical utility of contemporary diagnostic instruments for Spinal Cord Injury. **METHODS:** This is a prospective interventional study of adult patients with cervical spine injury over a period of 18 months. We recruited 60 patients and studied various prognostic factors such as age, gender, etiology, ASIA grades, level of injury, MRI findings and their influence on the outcome after the surgical intervention. We used statistical software SPSS version 25.0 for analysis of data. **RESULTS:** The study observed poor outcome after surgery in patients who are of old age, higher vertebral level of injury, poor grade ASIA (A and B) and MRI findings with contusions. **CONCLUSIONS:** The patient clinical parameters are significantly corelated with functional outcome in adult patients with traumatic cervical spine injury.

## KEYWORDS

ASIA: American Spinal cord Injury Impairment scale, MRI: Magnetic Resonance Imaging, tSCI: Traumatic Spinal Cord Injury, AIS: ASIA Impairment Score.

## INTRODUCTION

Traumatic spinal cord injury (SCI) is a serious disorder that has a profound impact on a patient's physical and psychosocial well-being. Patients with spinal cord injuries (SCI) principally suffer from motor and sensory deficits and dysfunction of the bladder and bowel, resulting in disabilities in daily activities.[1] An accurate assessment of the level and severity of the tSCI is the key for predicting functional outcomes.

ASIA Exam is a comprehensive classification tool for spinal cord injuries based on a standardized sensory and motor assessment was developed by the American Spinal Injury Association (ASIA) and had its most recent revision in 2019 [2].

This involves both a Motor and Sensory assessments to determine the Sensory Level and Motor Level for each side of the body (Right and Left), the single Neurological Level of Injury and whether the injury is Complete or Incomplete. The ASIA Impairment Scale classifies SCI into five categories from ASIA grade A (complete injury, no motor or sensory function) to ASIA grade E (normal examination). For individuals with evidence of SCI the initial neurological examination is the most important instrument for the assessment of the severity and level of the injury.

MRI has become the gold standard for imaging neurological tissues including the spinal cord. MRI is strongly recommended for the prognostication of acute spinal cord injury. The sagittal T2 sequence was particularly found to be of value. Four prognostication patterns were found to be predictive of neurological outcome (normal, single-level edema, multi-level edema, and mixed hemorrhage and edema). Early detection often leads to prompt and accurate diagnosis, expeditious management, and avoidance of unnecessary procedures. [3,4]

Although these studies have established MRI as a highly sensitive imaging modality, the clinical relevance of these findings is not evident in every case. Early studies have reported an overestimation of ligamentous injuries on MRI compared with subsequent surgical findings. More recently, Pourtaheri and associates found that in patients with known cervical fractures, MRI provided additional information only 48% of time, leading to the change of management in 39%. [5] Most new clinically significant information was related to the illustration on MRI of neural encroachment or spinal cord contusions from acute disk herniation or spondylosis, and not from occult instability. Age more than 60 years, neurological deficit, polytrauma status, alertness, and spondylosis were all associated with having additional clinically relevant findings on MRI. Contusions show normal images on T1 and central hypointensity with peripheral hyperintensity on T2-weighted while edema is similar on T1 but does not show central hypointensity on T2 images. The indications for MRI include the evaluation of gross neurological deficits, CT findings suggestive of neurological impingement, and neurological examination findings despite the absence of radiographic abnormalities.[6]

There is paucity of literature which shows that ASIA grading and Pattern of injury on MRI sequences may predict prognosis of cervical spine injury in Indian scenario. Thus, the aim of the present study was to study prognostic factors affecting outcome in traumatic cervical spine injury.

## MATERIALS AND METHODS

**STUDY DESIGN:** Prospective Interventional Study
**DURATION OF STUDY**: 18 months

**STUDY SETTING:** The study was conducted in Department of Neurosurgery, Vardhman Mahavir Medical College and Safdarjung Hospital, New Delhi.

**Inclusion Criteria:**
Patients with age >18 years
Spinal injuries from C1-C7
Patients who will be presenting to our institute within a week after injury

**Exclusion Criteria:**
Associated thoracolumbar and head injuries
Patients with penetrating injuries
Patient who will arrive at our institute after 7 days of injury
Patients with age <18 years

## SAMPLE SIZE CALCULATION

At 95% confidence level, 90% power and expecting correlation between MRI parameter and AIS at discharge in cervical spinal cord injury patients as -0.66 (Haefeli J et al) and with an absolute error of 5%, the sample size estimated was 21 using the formula

$$n = \left( \left( z_{1-\alpha/2} + z_{1-\beta} \right) / C \right)^2 + 3$$

where,

$$C = 0.05 * \ln\left[ (1+r)/(1-r) \right]$$

Where n = sample size

Zα = 1.96 value of the standard normal variate corresponding to level of significance alpha 5%

1-β = power of study =90%
r= correlation coefficient

So, 21 patients with traumatic spinal cord injury will be included in the study. However, sample size was kept for 60 in order to reduce the sample error.

## METHODOLOGY:

The study was conducted in the Department of Neurosurgery, Vardhman Mahavir Medical College and Safdarjung Hospital, New Delhi, after obtaining clearance from Hospital Ethical Committee.

Patients with cervical spinal injury who presented to Neurosurgery Department within a week of injury, and who will be surgically managed were included in the study. Informed written consent was obtained from each patient's parent or legal guardian.

All patients were assessed clinically by the American Spinal Injury Association (ASIA) scoring and grading system. Traumatic spinal cord injury was classified into five categories (score A with complete injury of spine, score B, C, D with incomplete injury and score E with no neural deficit) on the ASIA Impairment Scale. Apart from clinical parameters, the demographic parameters such as age, gender, surgical approach, mechanism and level of injury and type of fracture will be included in the study.

Magnetic resonance imaging (MRI) of all these patients was done. Quantification of damage in Spinal cord injury was measured based on the mid sagittal T1 and T2 weighted sequences. MRI findings were analyzed into two groups (a) contusion and (b) edema on the backdrop of time of injury and timing of MRI. For objective quantification of the length of lesion (edema/contusion), the mid-sagittal section of the MRI was divided based on the vertebral body and disc. The vertebral body was considered as two segments (upper and lower), and the adjacent disc was considered as an additional segment. Based on this, edema will be grouped as (a) ≤3 segments and (b) >3 segments.

The patients were further divided arbitrarily into two groups as per the timing of surgery following the injury into early (≤1 week) and late (>1 week). The preoperative plan was decided by a collegium of neurosurgeons of the department in the preoperative period. Surgery was performed by an independent supervising senior consultant.

All these patients were followed up in outpatient department at regular intervals. More than or equal to 1 grade change in ASIA grade from the date of admission to 2 months follow up was taken as improvement.

## ETHICAL CONSIDERATIONS

1. Informed written consent was taken from study subject's parents or legal guardian.
2. No pressure or coercion was exerted on subjects for participation in the study.
3. Confidentiality and privacy were ensured at all stages of the study period.
4. Subject were free to leave the study at any time and no questions were asked. They were not debarred from getting any medical services from the hospital.
5. The data collected is used for the study purpose only.

### Statistical Analysis

Data was simultaneously entered into proforma and was updated during review at 3 months. It was entered into Microsoft excel and Master Chart. The data were analyzed using SPSS software version 25.0. Statistical analysis of data among groups was done. Chi-Square test was applied as appropriate for comparison of nominal data. P value of 0.05 was considered as statistically significant.

## OBSERVATIONS AND RESULTS

It was a hospital based Prospective Intervention Study conducted in Neurosurgery, VMMC & Safdarjung Hospital, New Delhi, India, enrolling a total 60 patients with traumatic cervical spinal cord injury. The observations and results of the study are presented as below:

**Table 1: Age wise distribution of study subjects (n=60)**

| Age group | No. | % |
|---|---|---|
| 20-29 years | 12 | 20.0 |
| 30-39 years | 10 | 16.7 |
| 40-49 years | 18 | 30.0 |
| 50-59 years | 9 | 15.0 |
| ≥60 years | 11 | 18.3 |

Mean age was 43.23±14.05 years
As evidenced from the table above, most of the participants were from the age group of 40 to 49 years and mean age was 43.23 years.

**Table 2: Gender wise distribution of study subjects (n=60)**

| Gender | No. | % |
|---|---|---|
| Male | 51 | 85.0 |
| Female | 9 | 15.0 |

Most of the patients in our study were males as they accounted for 85% of the study subjects, out of all the 60 participants, 9 were female.

**Table 3: ASIA grade in study subjects (n=60)**

| ASIA grade | Preop (n=60) | At the end (n=51) |
|---|---|---|
| A | - | |
| B | 17 (28.3%) | 3(5.9%) |
| C | 39 (65%) | 15(29.4%) |
| D | 4 (6.7%) | 28(54.9%) |
| E | - | 5(9.8%) |

As evidenced by the table above patients with ASIA Grade C (65%) were the most common to present to our institute, followed by Grade B (28.3%).

**Table 4: Level of injury in study subjects (n=60)**

| Level of injury | No. | % |
|---|---|---|
| C3-C4 | 2 | 3.3 |
| C3-C4-C5 | 3 | 5.0 |
| C4 | 13 | 21.7 |
| C4-C5 | 5 | 8.3 |
| C4-C5-C6 | 2 | 3.3 |
| C5 | 17 | 28.3 |
| C5-C6 | 9 | 15.0 |
| C6 | 6 | 10.0 |
| C6-C7 | 1 | 1.7 |
| C7 | 2 | 3.3 |

In the present study the low cervical injury below C4 level was more common (58.3%) than high cervical injury (at or above C4).

**Table 5: MRI finding in study subjects (n=60)**

| MRI finding | No. | % |
|---|---|---|
| Cord oedema | 33 | 55.0 |
| Cord contusion | 27 | 45.0 |

In the present study cord oedema (55%) was found to be the most common MRI finding.

**Table 6: Glasgow outcome scale in study subjects (n=60)**

| Glasgow outcome scale | No. | % |
|---|---|---|
| 1 | 9 | 15.0 |
| 2 | 0 | 0.0 |
| 3 | 18 | 30.0 |
| 4 | 28 | 46.7 |
| 5 | 5 | 8.3 |

Many of the patients at 2-month follow-up had a Glasgow Outcome Scale of 4(46.7%). A total of 9(15%) patients died during the study.

**Table 7: Procedure done in study subjects (n=60)**

| Procedure | No. | % |
|---|---|---|
| Corpectomy with cage and plate fixation | 39 | 65.0 |
| Lateral mass fixation and laminectomy | 21 | 35.0 |

In the present study 39(65%) patients were operated with anterior approach in form of corpectomy with cage and plate fixation while 21 (35%) were operated using the posterior approach in form lateral mass fixation followed by laminectomy.

**Table 8: Association of MRI finding with ASIA grade in study subjects**

| ASIA grade | Oedema | Contusion |
|---|---|---|
| A | - | - |
| B | 0 | 3 (16.7%) |
| C | 1 (3%) | 14 (77.8%) |
| D | 2(81.8%) | 1 (5.6%) |
| E | 5 (15.2%) | 0 |

In the present study 27(81.8%) patients with ASIA grade D had cord oedema on MRI whereas 14(77.8%) patients with ASIA grade C had cord contusion on MRI.

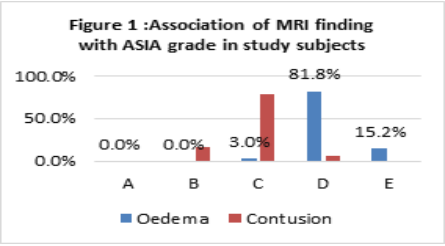


**Table 9: Factors associated with poor outcome in study subjects**

| | Poor outcome | Good outcome | P value |
|---|---|---|---|
| Mean age in years | 47.78±14.79 | 39.52±12.44 | 0.02 |
| Gender | | | |
| Male | 22 (43.1%) | 29 (56.9%) | 0.71 |
| Female | 5 (55.5%) | 4 (44.4%) | |
| MRI finding | | | |
| Oedema | 1 (3%) | 32 (97%) | <0.001 |
| Contusion | 26 (96.3%) | 1 (3.7%) | |
| Mechanism of injury | | | |
| Fall from height | 16 (59.7%) | 11 (40.3%) | 0.04 |
| RTA | 11 (33.3%) | 22 (66.7%) | |
| Level of injury | | | |
| C3-C4 | 14 (77.8%) | 4 (22.2%) | <0.001 |
| C5-C6-C7 | 13 (30.9%) | 29 (69.1%) | |
| Preop ASIA grade | | | |
| B | 16 (94.1%) | 1 (5.9%) | <0.001 |
| C | 11 (28.2%) | 28 (71.8%) | |
| D | 0 | 4 (100%) | |
| Procedure | | | |
| Corpectomy with cage and plate fixation | 16 (41%) | 23 (59%) | 0.39 |
| Lateral mass fixation and laminectomy | 11 (52.4%) | 10 (47.6%) | |

In the present study patients with good outcome had a mean age of 39.52 years. On MRI findings it has been noted that 32(97%) patients with good outcome had oedema whereas 26(96.3%) patients with poor outcome had contusion. In the study 14(77.8%) patients with high cervical spine injury (at or above C4) had poor outcome whereas 29(69.1%) patients with low cervical spine injury (below C4 level) had good outcome. In the present study 28 (71.8%) patients who presented with ASIA grade C had good outcome whereas 16(94.1%) patients who presented with ASIA grade B had poor outcome.

## DISCUSSION

The present study was a Prospective Intervention Study conducted in Neurosurgery, VMMC Medical College & Safdarjung Hospital, New Delhi, India, enrolling a total 60 patients with traumatic cervical spinal cord injury. The aim of the study was to study prognostic factors affecting outcome in traumatic cervical spine injury. We recruited 60 patients with traumatic cervical spinal cord injury and studied various prognostic factors such as age, gender, etiology, ASIA grades, level of injury, MRI findings and their influence on the outcome.

### Demography and outcome

Age has been the point of contention for neurological outcome and functional recovery. Although SCI commonly affects the young in their productive ages, extremes of ages are not spared with approximately 5.4% of individuals in an elderly age group (>65 years). According to National Spinal Cord Injury Statistical Center (NSCISC, Birmingham, Alabama, 2012) [7] the average age at injury is 41 years with 80% of SCI reported in males. In this study, the average age was 43.23 years with 85% cases being males. Most common etiology, according to NSCISC, motor vehicular accidents correspond to 39%. In this study, RTA contributed to 55% of cases. Published data favors good improvement for young individuals [Table 10]. In this study patients with good outcome had a mean age of 39.52 years which is in accord with the data available in previous study.

**Table 10: Demographic comparison in literature**

| Author and year | Outcome |
|---|---|
| Waters et al. 1993[8] | Complete cervical injuries >65 years had worst prognosis |
| McKinley et al. 2003[9] | Older individuals have poorer outcome |
| Fisher et al. 2005[10] | Age <24 years better outcome |
| Van Hedel and Curt 2006[11] | Poorer outcomes with increasing age |
| Pickett et al. 2006[12] | Mortality increases with age |

### Clinical parameters

Several studies have focused on initial neurological grade, the level of injury affecting outcome. Coleman and Geisler [13] opined that the severity of the injury was the primary predictor of outcome in acute SCI, reported that ASIA Grades C and D had marked recovery as compared to ASIA Grade B, which did better than Group A.

Vazquez et al.,[14] in their study for 173 traumatic cervical SCI patients concluded that rate of improvement was least in ASIA Grade A patients, and none of them were functional. In contrast, incomplete injury patients had better recovery. Shao et al.,[15] analyzed retrospectively, 1163 patients with cervical SCI, opined that higher level (C1-C4), with complete cervical SCI having worst outcome.

Burns et al.,[16] studied the effect of age and initial neurologic status on the recovery of ambulation in patients with incomplete injuries. They concluded that in patients with ASIA Grade D, prognosis for recovery to independent ambulation was excellent irrespective of age. For patients with ASIA Grade C, recovery to ambulation was related to age (<50 years - 91% patients improved; >50 years - 42% improvement).

In this study 16(94.1%) patients with ASIA B grade had poor outcome whereas 28(71.8%) patients with ASIA grade C had poor outcome. No patient had neurological grade deterioration.

In this study, the incidence of lower (below C4) cervical injuries was high (69%) when compared with high (at or above C4) cervical injuries (31%). In this study 29(69.1%) patients with lower cervical injury had good outcome as compared to 4(22.2%) patients with upper cervical injury.

### Magnetic resonance imaging and outcome

A number of studies proved that MRI had been the gold standard in prognostication of cervical SCI. It allows good visualization of neurological tissues such as cord, ligaments, discs, vessels as well as soft tissues.

Kulkarni et al., (1987)[17] were first to characterize three MRI signal patterns for the prognostication of acute SCI: (1) Hemorrhage in the cord (2) edema of the cord and (3) a combination of hemorrhage and edema. Prognostication patterns used today are variations of these original patterns.

Ramón et al.,[18] described six patterns of MRI in acute SCI.
Provenzale,[19] described MRI evaluation of anatomic structures which can help, determine the cause and extent of the neurological deficit, the probable mechanism of injury, and the presence of spinal instability.

In the literature, sagittal T2 sequences had the highest correlation with patient prognosis as they can identify and measure the extent of edema and hemorrhage/contusion within the spinal cord.

Bozzo et al.,[20] in his review, reported that patients with normal MRI improved to ASIA Grade E regardless of their initial neurological status. He described, four signal patterns based on sagittal

T2-weighted sequences are commonly used in the literature. Pattern 1 shows a normal MRI signal in the cord, Pattern 2 represents single-level edema, Pattern 3 is multi-level edema, and Pattern 4 is mixed hemorrhage and edema, which were in fact imbibed from previous studies. [21-23]

In this study, we merged hemorrhage and contusion into single category and named as contusion group. It is analogous to type 1 and 2 patterns of Kulkarni et al. We had no patient in transaction pattern. MR imageology of cervical spine is categorized into two groups, named as edema and contusion groups. In this study 33(55%) patients had edema; 27(45%) patients had contusion. A similar result noted in previous Kulkarni et al., Ramón et al., Bozzo et al., all of those showing edema was most common imageological finding. 26(96.3%) patients in contusion group had poor outcome at 2 months follow-up, whereas 32(97%) patients in the edema group had good outcome which was statistically significant (P = <0,001). Mortality in contusion and edema group was 33.3%.

## SUMMARY AND CONCLUSION

Our Prospective Intervention Study showed that a majority of the patients were from the age group of 40 to 49 years and mean age was 43.23 years. Most of the patients in our study were males as they accounted for 85% of the study subjects. The most common mode of injury was road traffic accidents (55%).

It was noticed that patients with respect to ASIA impairment scale, ASIA Grade C (65%) is the most common grade, followed by Grade B (28.3%).

With respect to level of cervical spine injury, low cervical injury (below C4 level) was more common (58.3%) than high cervical injury (at or above C4). Regarding radiological findings, cord oedema (55%) was found to be the most common MRI finding.

In our study majority of the patients at 2-month follow-up had a Glasgow Outcome Scale of 4(46.7%). A total of 9(15%) patients died during the course of the study.

In the present study 27(81.8%) patients with ASIA grade D had cord oedema on MRI whereas 14(77.8%) patients with ASIA grade C had cord contusion on MRI. In the present study patients with good outcome had a mean age of 39.52 years. On MRI findings it has been noted that 32(97%) patients with good outcome had oedema whereas 26(96.3%) patients with poor outcome had contusion.

In the study 14(77.8%) patients with high cervical spine injury (at or above C4) had poor outcome whereas 29(69.1%) patients with low cervical spine injury (below C4 level) had good outcome. In the present study 28 (71.8%) patients who presented with ASIA grade C had good outcome whereas 16(94.1%) patients who presented with ASIA grade B had poor outcome.

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